

In-Use Off-road Diesel Vehicle Regulation Individual Fleet Cost Analysis



July 16, 2007
Sacramento, California

Heavy-Duty Diesel In-Use Strategies Branch

California Environmental Protection Agency



Air Resources Board

1

Outline

- Proposed regulation overview
- Fleet meetings
- Fleet compliance options
- Cash flow analysis method
- Findings



2

Review of Proposed Regulation



3

Regulation Overview

- Applies to off-road vehicle engines over 25 hp
- Beginning in 2009
 - Labeling and annual reporting
 - Idling limits
 - Limits on adding dirty vehicles to fleets
- Control requirements begin
 - 2010 for large fleets
 - 2013 for medium fleets
 - 2015 for small fleets



4

Two Options to Comply

- Meet fleet emission targets by any method
or
- Demonstrate progress in reducing emissions
 - Called Best Available Control Technology (BACT) requirements
 - “Safety valve” for fleets that cannot meet targets

5

Compliance Actions

- Install NOx or PM exhaust retrofits
- Buy cleaner new or used vehicles
- Install cleaner engines (repower)
- Retire dirty vehicles



6

BACT Requirements “A Safety Valve”

- Fleets never required to do more than BACT requirements
- Apply PM retrofits to meet PM requirements
 - 20% of hp per year
 - No action required if not available
- Turn over engines to meet NOx requirements
 - 8-10% of hp per year
 - Engine turnover reduced with NOx retrofits
- Once fleet averages are met, fleets will do less

7

Requirements Vary by Fleet Size

Fleet Size Category	Description	Dates and Requirement
Small	Small business less than 1,500 hp or Municipality less than 1,500 hp or Municipality fleet in low population county	2015-2025 PM only
Medium*	Municipality with 1,501 to 5,000 hp or Business less than 5,000 hp (not “Small”)	2013-2020 PM and NOx
Large*	Fleets with more than 5,000 hp	2010-2020 PM and NOx

* Same requirements for large and medium fleets, only initial compliance date varies.

8

Annual Compliance Process

Large and Medium Fleets

Either meet NOx
target or do 8% or
10% turn over

Either meet PM
target or do 20%
retrofits

Done
for
year

9

Special Provisions

- Exemptions or compliance extensions
 - Low-use vehicles
 - Vehicles in attainment areas
 - Manufacturer delays
- No retrofit requirements
 - Engines in vehicles less than 5 years old
 - No retrofit available
 - Retrofit not safe
- No turnover requirements
 - Small fleet
 - Used vehicle and repower not available
 - Less than 10 years old, or retrofit in past 6 years

10

Regulation Provides Credit

- NOx retrofits in lieu of BACT turnover
- Early repowers and turnover
- Electric and alternative fuel vehicles
 - Double credit for turnover to electric vehicles
- Double credit for early PM retrofits



11

Meetings with Fleets



12

Goals

- Better understand fleet operations and most cost effective compliance strategies
- Determine regulation's impact on bottom line
 - Cash flow, income, debt load
- Discuss suggestions for improving regulation

13

Summary of Meetings

- Most fleets' own cost estimates agreed well with ARB staff estimates
- Evaluated early compliance options
- Some misunderstandings of requirements
- Staff detailed cash flow analyses being reviewed by some fleets
- Most fleets did not share financial information

14

Fleets Evaluated After May Board Hearing

- Company Types
 - Equipment rental
 - Grading
 - General contracting
 - Underground
 - Mining
- Locations
 - 2 Northern California
 - 1 Central California
 - 6 Southern California

15

Fleet Characteristics

Average Vehicle Age	Number of Vehicles	Total hp
6.3	156	81,000
7.1	321	99,000
5.2	11	3,000
8.1	127	20,000
9.8	112	41,000
10.6	19	8,000
12.0	49	12,000
12.9	235	45,000
18.9	102	28,000

16

Key Issues

- Concerns about PM retrofit technology
 - Costs of existing systems
 - Uncertainty of available options
 - Technology, installation, and reliability
- Comparison of costs to baseline costs (without regulation)
- Ability to pass on costs

17

Retrofit Technology

- Filter substrate traps PM
- Key differences in regeneration method
- Passive systems
 - Needs higher exhaust temperatures
 - Automatic regeneration while operating
 - Lower cost option
- Active systems
 - Exhaust temperature/duty cycle unimportant
 - Uses fuel or electricity to generate heat
 - Regenerates with engine off or while running



18

Level 3 Diesel Particulate Filters Currently Verified for Off-road Use

Product	Applicability
Cleaire Horizon	Most Tier 1 and higher off-road engines
Huss Umwelttechnik FS_MK	Most on-road and off-road diesel engines through 2007 model year
Engine Control System Combifilter	1996-2004 off-road engines

Note: 22 Level 2 and Level 3 systems verified for other applications

19

Other PM Retrofit Systems

- Several off-road demonstrations in progress
- Off-road showcase applications from dozens of retrofit suppliers
- Every new on-road engine sold in US has particulate filter
 - 780,000 vehicles per year
 - Estimated price increase with filter about \$7,000
- Over 2,000 filters installed on trash trucks
 - Duty cycle similar to off-road (350 hp engines)
 - Most are passive systems and cost less than \$10,000
- Public fleets milestone at end of year
 - Several hundred expected to be installed

20

Active DPFs



21

NOx + PM Controls



22

NY Croton Project



23

Comparison to Baseline

- Costs from regulatory requirements must be compared to costs without regulation
- Normal turnover rate determines baseline
 - Establishes cost for turnover without regulation

Turnover Rate	Equivalent to keeping vehicles for
1%	100 years
2%	50 years
4%	25 years
5%	20 years

24

Ability to Pass on Costs

- All fleets subject to regulation
- Most agree they will be able to pass on some costs
 - Competition with small and medium fleets an issue
- Newest fleets will also face higher costs with Tier 4 engines
 - New vehicles will have filters starting in 2012

25

Cash Flow Analysis Method



26

Approach to Analysis

- Capital costs with regulation vs costs without
 - Evaluated variety of compliance strategies
 - Tailored compliance strategies for each company
- Used same prices/costs from staff report
- All costs in 2006 dollars
- Did not model growth
 - Growth with newer vehicles improves fleet averages
- Detailed cash flow analysis

27

Incremental Cash Flow Analysis

- Loan interest rate and period
- Age and number of vehicles purchased
- Income and property tax
- Depreciation
 - Taxes and book value
- Revenue increases with newer vehicles
 - Productivity, rates, fewer service calls
- Lower repair costs
- Fuel economy improvements

28

PM Exhaust Retrofit Costs

Costs Used in Staff Report (Active and Passive DPF)

Engine Size	Total Price
Less than 50 hp	\$8,000
50 to 175 hp	\$12,000
175 to 300 hp	\$18,000
Greater than 300 hp	\$30,000

Actual Price Quotes for Huss Systems (Active DPF)

Engine Size	Number of Quotes	Median Price
Less than 50 hp	0	NA
50 to 175 hp	94	\$13,928
175 to 390 hp	15	\$19,512
394 hp	1	\$48,858

29

Repower Costs

- Tier 0 to Tier 2 or 3
 - \$270/hp
- Tier 0 to Tier 1 (for early credit)
 - \$135/hp

30

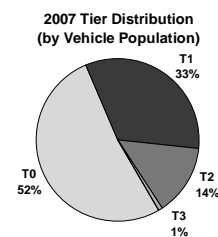
Fleet Analysis



31

Fleet A – Background Information

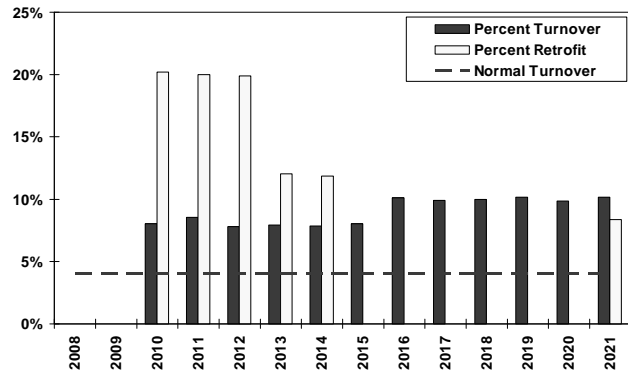
- Rental Company
- Average age, 12.9
- Turnover vehicles after 25 years (4%)
- Buy 2 to 5 year old vehicles
- Dozers, rollers, excavators, scrapers
- Revenue about \$10,000,000



32

Fleet A – Highest PM Retrofit Cost

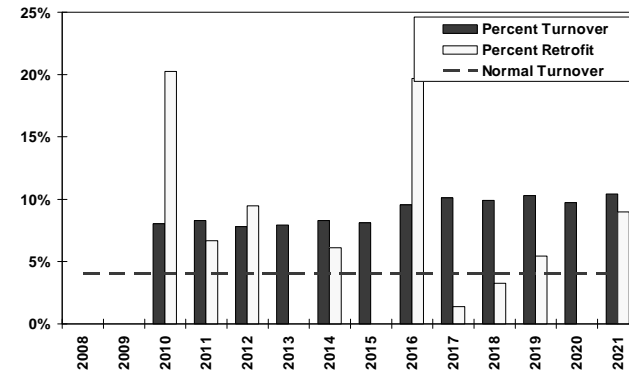
No early actions, retrofit cleaner engines first, buy 6 year old vehicles



33

Fleet A – Lower Retrofit Costs

Retrofit older Engines First, 6 year old replacement vehicles



34

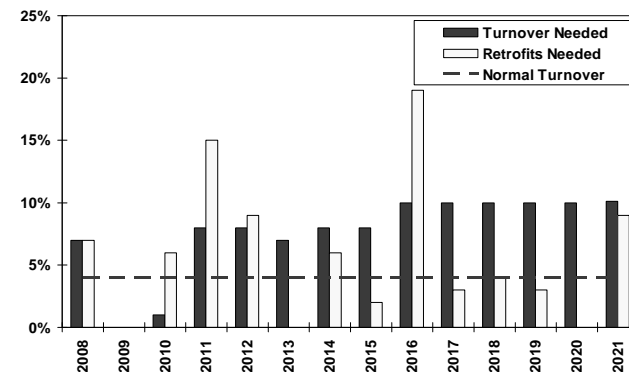
Fleet A – Compliance Strategy Evaluated Spread Out Costs with Early Actions

- Early credit
 - Repower 7% of hp to Tier 1 and install PM retrofits on same engines
- Turnover oldest vehicles with 6 year old used vehicles
- Install PM retrofits on dirtier engines first

35

Fleet A – Most Likely Choice

Early Tier 1 Repowers and PM Retrofits, retrofit dirtier engines first, buy 6 year old vehicles



36

Fleet A – Incremental Capital Costs Lower Cost Option

Year	Incremental Capital Expense			Costs Attributed to Regulation
	Turnover	Repowers	VDECS	
2008	\$0	(\$284,807)	(\$163,265)	(\$448,073)
2009	\$0	\$0	\$0	\$0
2010	\$687,500	\$0	(\$253,392)	\$434,107
2011	(\$596,076)	\$0	(\$449,744)	(\$1,045,820)
2012	(\$112,329)	\$0	(\$219,387)	(\$331,717)
2013	(\$363,176)	\$0	\$0	(\$363,176)
2014	(\$141,348)	\$0	(\$146,197)	(\$287,545)
2015	(\$195,162)	\$0	(\$38,677)	(\$233,838)
2016	\$46,943	\$0	(\$438,334)	(\$391,391)
2017	(\$686,836)	\$0	(\$70,162)	(\$756,997)
2018	(\$357,090)	\$0	(\$73,503)	(\$430,592)
2019	(\$342,885)	\$0	(\$38,183)	(\$381,068)
2020	(\$351,117)	\$0	\$0	(\$351,117)

37

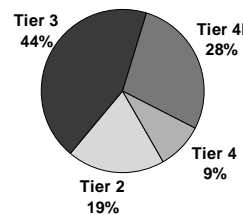
Fleet A - Cash Flow Analysis 1% Increase in Revenue

Calendar Year	Cash Flow	Income	Cumulative Debt Remaining
2008	(\$93,999)	(\$48,259)	(\$372,393)
2009	(\$96,727)	(\$44,560)	(\$290,359)
2010	(\$122,289)	(\$116,753)	\$205,210
2011	(\$170,799)	(\$67,219)	(\$611,383)
2012	\$13,303	\$156,279	(\$652,362)
2013	\$155,384	\$232,508	(\$766,440)
2014	\$181,373	\$295,071	(\$749,144)
2015	\$191,219	\$464,864	(\$502,604)
2016	\$381,292	\$470,337	(\$572,123)
2017	\$341,905	\$451,420	(\$936,314)
2018	\$371,693	\$466,398	(\$960,204)
2019	\$347,618	\$442,830	(\$908,657)
2020	\$317,508	\$426,001	(\$790,471)
2021	\$237,770	\$296,115	(\$426,316)

38

Fleet A – Tier Distribution in 2020 Does not Require All Tier 4

Tier Distribution by Horsepower

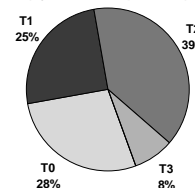


39

Fleet B - Background

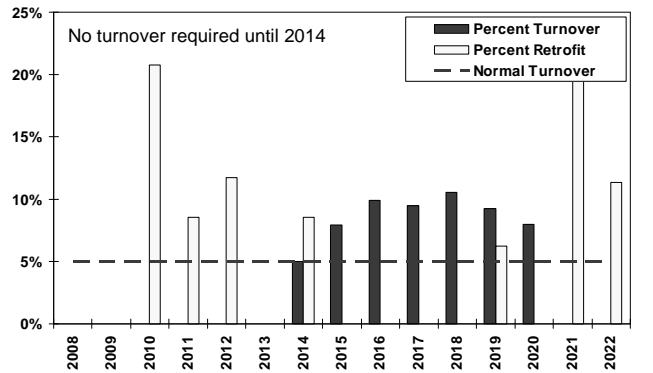
- Grading (Public/Residential)
- Average age, 9.5 years
- Turnover vehicles after 50 years (2%)
- Replace with some new, some used
- Scrapers, excavators, tractors/loaders/backhoes, crawler tractors
- Early Action: Repowered 30% of fleet

2007 Tier Distribution
(by Vehicle Population)



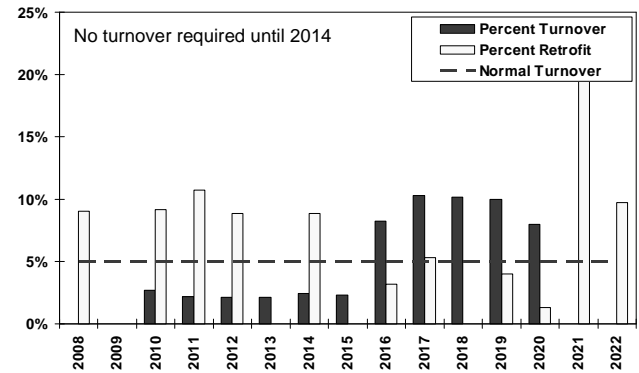
40

Fleet B – Minimum Early Turnover Retrofit Older Vehicles First Existing Early Credit from Repowers



41

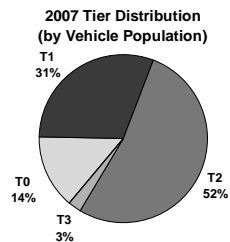
Fleet B – Likely Scenario Retrofit Older Vehicles First, Existing Early Credit Repowers and Retrofits



42

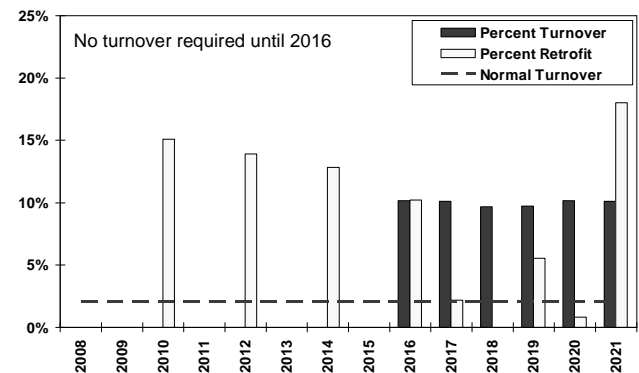
Fleet C - Background

- Earthmoving
- Average age, 6 years
- Turnover vehicles after 50 years (2%)
- Buy mostly new vehicles
- Scrapers, crawler tractors, loaders and dozers
- Early action: Repowered 50% of fleet



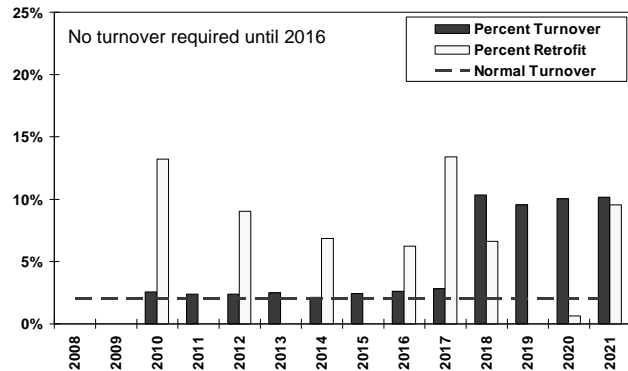
43

Fleet C – Minimum Turnover Retrofit Older Vehicles First Existing Early Credit for Repowers



44

Fleet C – Normal Turnover Retrofit Older Vehicles First Existing Early Credit for Repowers



45

Cash Flow Results and Conclusions

- Early actions provide opportunity to lower costs in early years
- Regulation provides flexibility for fleet to tailor to their needs
- Replacement cost of oldest vehicles often offset by other factors
 - Depreciation
 - Lower repair costs
 - Increased reliability/productivity/revenue
- Financing spreads out costs
- Capital costs alone not sufficient to determine impact on income and revenue

46